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THE IMPORTANCE OF AEROSOL COMPOSITION AND MIXING STATE ON PREDICTED CCN CONCENTRATION AND THE VARIATION OF THE IMPORTANCE WITH ATMOSPHERIC PROCESSING OF AEROSOL

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ABSTRACT

The influences of atmospheric aerosols on cloud properties (i.e., aerosol indirect effects) strongly depend on the aerosol CCN concentrations, which can be effectively predicted from detailed aerosol size distribution, mixing state, and chemical composition using Köhler theory. However, atmospheric aerosols are complex and heterogeneous mixtures of a large number of species that cannot be individually simulated in global or regional models due to computational constraints. Furthermore, the thermodynamic properties or even the molecular identities of many organic species present in ambient aerosols are often not known to predict their cloud-activation behavior using Köhler theory. As a result, simplified presentations of aerosol composition and mixing state are necessary for large-scale models. In this study, aerosol microphysics, CCN concentrations, and chemical composition measured at the T0 urban super-site in Mexico City during MILAGRO are analyzed. During the campaign in March 2006, aerosol size distribution and composition often showed strong diurnal variation as a result of both primary emissions and aging of aerosols through coagulation and local photochemical production of secondary aerosol species. The submicron aerosol composition was ~1/2 organic species. Closure analysis is first carried out by comparing CCN concentrations calculated from the measured aerosol size distribution, mixing state, and chemical composition using extended Köhler theory to concurrent CCN measurements at five supersaturations ranging from 0.11% to 0.35%. The closure agreement and its diurnal variation are studied. CCN concentrations are also derived using various simplifications of the measured aerosol mixing state and chemical composition. The biases associated with these simplifications are compared for different supersaturations, and the variation of the biases is examined as a function of aerosol age. The results show that the simplification of internally mixed, size-independent particle composition leads to substantial overestimation of CCN concentration for freshly emitted aerosols in early morning, but can reasonably predict the CCN concentration after the aerosols underwent atmospheric processing for several hours. This analysis employing various simplifications provides insights into the essential information of particle chemical composition that needs to be represented in models to adequately predict CCN concentration and cloud microphysics.

This poster will be displayed at ASR Science Team Meeting.